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# Stability of International Production Networks: Is East Asia Special?[1]

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**Abstract**

**Trade relationships built through production chains appear to be lasting due to relation-specific nature of the transactions, compared with the usual transactions of goods sold on the open market. This paper aims to verify such stability of international production networks at the global level, with special emphasis on intra-East Asian trade. A series of survival analyses provide an evidence suggesting that the stability of international production networks is a particularly prominent feature of East Asia. In addition, East Asian countries are more likely to engage in long-lasting trade relationships of intermediate goods with each other than with outsiders as well as compared to outside the region, unlike in the case of finished products.**

**Keywords: Duration of trade, fragmentation, East Asia.**

**JEL Classification: F10, F14**

## 1. Introduction

The East Asian region has been attracting much attention for the unprecedented development of international production networks with vigorous cross-border transactions of intermediate goods. Regional diversity in income levels and development stages has promoted opportunities for multinational enterprises to locate fragmented

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production processes in different locations with different location advantages across East Asia.[1] Accordingly, through back-and-forth transactions of relevant intermediate goods for manufacturing or assembly of a certain product, countries taking part in the networks have deepened economic dependence on one another. Such mutual ties have been built through production chains stretched across East Asia, particularly in machinery industries, since the beginning of the 1990s (See Fukao *et al.*, 2003; Athukorala and Yamashita, 2006; Kimura, 2006).

Trade relationships built through production chains appear to be lasting rather than footloose, unless they become less economically important. Given the need for coordination between upstream and downstream production processes as well as the presence of sunk costs of investing in newly fragmented production block, the network-forming firms would put priority not only on lowering production costs but on the sustainability of trade relationships.[2] In this sense, cross-border transactions of intermediate goods within production networks are necessarily based on special relationship, unlike in the case of exports/imports of finished products made from start to finish in one country as well as goods sold on the open market. Due to such relation-specific nature of the transaction, once a trade relationship is established, it would appear that the transaction of intermediate goods within production networks is more lasting compared to other transactions across borders.[3]

Further to previous studies that present the stability and resilience of international production networks in East Asia (Obashi, 2009, 2010), the current paper provides an evidence for the lasting tendency of the transactions of intermediate goods within the networks in the wider global context. The paper also examines whether such stability of

[1] For the fragmentation theory, see Jones and Kierzkowski (1990), Arndt and Kierkowski (2001), and Deadorff (2001). In terms of international production networks in East Asia, Kimura and Ando (2005) claim the two-dimensional concept of fragmentation.

[2] As a source of hysteresis in exports at the firm level, the role of sunk costs to enter the export market has been examined theoretically (Baldwin, 1988; Baldwin and Krugman, 1989; Dixit, 1989a,b) and empirically (Roberts and Tybout, 1997; Bernard and Jensen, 2004).

[3] Of course, naturally, less economically important trade relationships might be broken off in the process of restructuring the networks to be more efficient or sophisticated.

international production networks is a particularly prominent feature of East Asia by comparing intra-East Asian trade with other trade flows. Reflecting strong mutual ties built through production chains stretched across East Asia unlike any other regions in the world, it would appear that intra-East Asian trade relationships of intermediate goods within the networks are more lasting compared to extra-regional trade relationships as well as transactions outside the region.[1]

To examine the probability of continuance once a trade relationship is established, survival analysis is conducted using highly disaggregated trade data at the country-product level, as in the previous studies. In the light of the fact that the machinery industry extends the most sophisticated production networks in East Asia and other regions, along with active transactions of intermediate goods across borders, this paper examines trade relationships of machinery parts & components, in comparison with those of finished products. A series of survival analyses highlight that trade relationships of machinery parts & components, particularly among East Asian countries, have a higher probability of continuance compared to those of finished products. In addition, East Asian countries are more likely to engage in long-lasting trade relationships of parts & components with each other than with outsiders as well as compared to outside the region, unlike in the case of finished products.

This paper contributes to a pioneering work on duration of trade by Besedeš and Prusa (2006a,b), from the perspective of international fragmentation of production, with special emphasis on the East Asian region. Besedeš and Prusa (2006a), who first investigated the duration of the US imports, find the observed trade relationships at the country-product level to be surprisingly volatile.[2]

[1] The building of long-lasting trade relationships within international production networks would be one of the important driving forces behind a striking growth of intra-East Asian trade for the last couple of decades. A rigorous analysis on this topic is left for future research.

[2] Besedeš and Prusa (2006a) find that only 67% of trade relationships survive one year, and 49% survive four years over the period from 1972 to 1988 at the 7-digit level of Tariff Schedule (TS) of the United States. Regarding the observed short-lived trade relationships, Besedeš and Prusa discuss potential explanations including the Ricardian comparative advantage model, the product cycle model as well as the model of trade and search costs.

As their companion paper, Besedeš and Prusa (2006b) highlight that differentiated products have a longer duration and a higher probability of continuance than othergoods, based on a search cost model of international trade.[1] Besedeš (2008) provides additional facts on the duration of the US imports from the search cost perspective. A considerable amount of short-lived trade relationships has been also observed in Blyde (2008) for exports by Latin American countries, Nitch (2009) for German imports, and Obashi (2010) for intra-East Asian trade in machinery.[2]

The rest of this paper proceeds as follows: the next section presents unexplored facts on the duration of trade for trade in machinery at the global level as well as by the disaggregated trade flows, with special emphasis on intra-East Asian trade. Section 3 examines the difference in the probability of the continuance of trading between machinery parts & components and finished products, employing the Kaplan-Meier method and the Cox proportional hazard model. The East Asian specificity in terms of a higher probability of continuance for intra-regional trade compared to other trade flows is also to be investigated. And the last section concludes with interpretations of the empirical results.

## 2. Duration of trade in machinery

The duration and survival of trade relationships are to be examined using bilateral trade data at the 6-digit level of Harmonized System (HS) from 1993 to 2007 obtained from the United Nations Commodity Trade Statistics Database (UN Comtrade).[3] The HS 6-digit level is the most detailed disaggregated level of trade data that is internationally

[1] According to Besedeš and Prusa (2006b), 69% of the trade relationships of differentiated products survive one year, while only 53% and 59% of the trade relationships of homogeneous goods and reference priced products do. At the fourth year, these rates decline to 52% for differentiated products and 33-38% for the other goods.

[2] The commonness of short-lived trade relationships is closely related to recent evidence of the existence of zero values in the bilateral trade matrix, which has been highlighted in the context of the adequacy of standard specifications of the gravity equation (Haveman and Hummels, 2004; Helpman *et al.*, 2008).

[3] Appendix A1 provides details on data construction.

comparable and publically available.[1] At the 6-digit level of the HS 1992 classification, there exist 4,013 product lines for all manufacturing industries (HS28-92) and 1,124 for machinery industry (HS84-92), the latter of which are grouped into 436 parts & components and 688 finished products, following the list proposed by Ando and Kimura (2005). Dataset used in this paper contain information on bilateral trade engaged in by 225 countries/regions that form 18,485 exporter-importer pairs, either or both of which have continuously reported trade statistics according to the HS classification and have traded any manufactured goods with any partner during the sample period 1993-2007. Since the set of 225 countries/regions are quite broad in scope, including small island countries/regions that would be economically less important in the global context, this paper basically report the statistics and empirical results obtained using the sample restricted to the exporter-importer pairs that account for 99% of the total volume of trade in manufactured goods in the sample period. Consequently, the sample comprises 151 exporters and 177 importers that form 3,277 pairs.[2]

To investigate East Asian specificity from the perspective of the duration and survival of trade, this paper compares intra-East Asian trade with East Asian exports to and imports from other regions as well as transactions outside the East Asian region. East Asia here includes nine countries/regions and 72 (= 9*8) pairs, namely, ASEAN4 (Indonesia, Malaysia, the Philippines, Thailand), NIEs3 (Hong Kong, Rep. of Korea, Singapore), China, and Japan.

By using the country-product level trade data, whether a trade relationship is active in a given year can be identified for each exporter-importer-product pair. Table1 reports the basic statistics for the number of years in which a trade relationship is active during 1993-2007 (15

[1] Although some may argue that the HS 6-digit is too coarse to be regarded as a single product, the probability of discontinuing transactions at the "actual" product level will never be overestimated, as with an advantage of using the old but unchanging product classification. See Appendix A1 for further discussions.

[2] The numbers of countries/regions and pairs in samples with different cutoff percentages applied to the total trade volume of manufactured goods are reported in Appendix A2. The statistics and empirical results do not differ qualitatively by the cutoff percentages.

years) for trade in machinery. For the exporter-importer-product pairs that are observed for at least one year during the period, the mean number of years active is 7.9 for parts & components, which is 1.3 points higher than finished products.[1] In addition, as indicated by the ratio of the number of the observed exporter-importer-product pairs to the maximal possible number of pairs, *i.e.*, the number of exporter-importer pairs multiplied by the number of product lines, trade relationships of parts & components (66%) are more active than those of finished goods (55%).

**Table 1. Number of years active by exporter-importer-product pair for trade in machinery during 1993-2007.**

| | Mean | Median | Cumulative percentages by number of years active | | | Obs. | Share in the max. possible N. | N. of product lines | N. of exporter-importer pairs in the sample |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 7 | 14 | | | | |
| Overall world trade | | | | | | | | | |
| P&C | 7.9 | 7 | 15% | 50% | 79% | 936,795 | 66% | 436 | 3,277 |
| FP | 6.6 | 5 | 21% | 61% | 87% | 1,241,754 | 55% | 688 | |
| P&C | | | | | | | | | |
| Intra-EA trade | 10.9 | 14 | 6% | 27% | 57% | 28,412 | 91% | 436 | 72 |
| EA exports to other regions | 7.4 | 7 | 15% | 54% | 85% | 188,305 | 69% | | 630 |
| EA imports from other regions | 7.8 | 7 | 17% | 52% | 77% | 89,897 | 52% | | 395 |
| Outside-EA trade | 7.9 | 8 | 15% | 50% | 79% | 630,181 | 66% | | 2,180 |
| FP | | | | | | | | | |
| Intra-EA trade | 8.8 | 9 | 11% | 44% | 74% | 40,079 | 81% | 688 | 72 |
| EA exports to other regions | 6.2 | 5 | 21% | 64% | 90% | 252,637 | 58% | | 630 |
| EA imports from other regions | 6.4 | 5 | 24% | 63% | 85% | 108,085 | 40% | | 395 |
| Outside-EA trade | 6.6 | 5 | 21% | 61% | 86% | 840,953 | 56% | | 2,180 |

*Notes*: Trade in machinery is grouped into parts & components (P&C) and finished products (FP). For each of product types, overall world trade is grouped into four trade flows: intra-East Asian trade, East Asian exports to other regions, East Asian imports from other regions, and trade outside the East Asian region. Exporter-importer-product pairs that have been inactive throughout the sample period 1993-2007 are not included in the above basic statistics.

The lower part of Table 1 compares four different trade flows, *i.e.*, intra-East Asian trade, East Asian exports to other regions, East Asian imports from other regions, and outside-East Asia trade, as well as the comparison between product types. Although the larger number of

[1] The exporter-importer-product pairs that are inactive throughout the period are not included in the basic statistics reported in Table 1.

years active and the higher proportion of the observed exporter-importer-product pairs for parts & components are characteristics common to all, the figures for intra-East Asian trade are saliently high. In particular, the observed trade relationships of parts & components among East Asian countries are on average active for 10.9 years, and those observed pairs account for 91% of the maximal possible number of pairs.

These facts regarding the existence of zeros in the bilateral trade matrix appear to be closely related to how long a trade relationship is continued without interruption. For instance, if country *i* started to export product *h* to country *j* in 2000 and ceased to export the product in 2004, the trade relationship is regarded as having a spell length of four. As some of trade relationships were broken off and restored after a certain period, at least a year, which is referred to as multiple spells, the number of spells by exporter-importer-product pair as well as the length of each spell should be examined. Tables 2 and 3 report the basic statistics for the number of spells and for their lengths, respectively.[1]

**Table 2. Number of spells by exporter-importer-product pair for trade in machinery during 1993-2007.**

| | Mean | Median | Cumulative percentages by number of spells | | | | Obs. |
|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | |
| Overall world trade | | | | | | | |
| P&C | 1.87 | 1 | 50% | 75% | 91% | 98% | 936,795 |
| FP | 1.94 | 2 | 46% | 73% | 90% | 98% | 1,241,754 |
| P&C | | | | | | | |
| Intra-EA trade | 1.72 | 1 | 59% | 79% | 92% | 98% | 28,412 |
| EA exports to other regions | 1.88 | 2 | 48% | 75% | 91% | 98% | 188,305 |
| EA imports from other regions | 1.84 | 1 | 52% | 76% | 91% | 98% | 89,897 |
| Outside-EA trade | 1.87 | 1 | 50% | 75% | 91% | 98% | 630,181 |
| FP | | | | | | | |
| Intra-EA trade | 1.96 | 2 | 47% | 71% | 89% | 97% | 40,079 |
| EA exports to other regions | 1.91 | 2 | 46% | 74% | 91% | 98% | 252,637 |
| EA imports from other regions | 1.93 | 2 | 48% | 73% | 89% | 97% | 108,085 |
| Outside-EA trade | 1.95 | 2 | 46% | 72% | 89% | 97% | 840,953 |

*Note*: Exporter-importer-product pairs of active trade relationships only.

[1] As multiple spells are treated as independent, the size of observations in Table 3 is larger than that in Table 2.

**Table 3. Length of spells for bilateral trade relationships at the product-line level in trade in machinery during 1993-2007.**

| | Mean | Median | Cumulative percentages by length of spells | | | | | Obs. |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 4 | 7 | 10 | |
| Overall world trade | | | | | | | | |
| P&C | 4.2 | 2 | 46% | 60% | 72% | 80% | 85% | 1,747,297 |
| FP | 3.4 | 1 | 52% | 67% | 79% | 86% | 90% | 2,410,649 |
| P&C | | | | | | | | |
| Intra-EA trade | 6.3 | 3 | 33% | 45% | 56% | 64% | 69% | 48,929 |
| EA exports to other regions | 3.9 | 2 | 47% | 61% | 74% | 82% | 87% | 354,676 |
| EA imports from other regions | 4.2 | 2 | 46% | 61% | 73% | 80% | 85% | 165,533 |
| Outside-EA trade | 4.2 | 2 | 46% | 60% | 72% | 79% | 85% | 1,178,159 |
| FP | | | | | | | | |
| Intra-EA trade | 4.5 | 2 | 43% | 58% | 70% | 79% | 83% | 78,682 |
| EA exports to other regions | 3.2 | 1 | 52% | 68% | 80% | 87% | 91% | 482,527 |
| EA imports from other regions | 3.3 | 1 | 53% | 69% | 80% | 87% | 90% | 209,059 |
| Outside-EA trade | 3.4 | 1 | 52% | 68% | 79% | 86% | 90% | 1,640,381 |

*Note*: Active trade relationships only.

For overall world trade, 50-54% of exporter-importer-product pairs experience multiple spells, and half of them, 25-27% experience more than two spells. Even with aggregated trade data at the country level rather than data on the firm-level export activities, the break and restoration of trade relationships occur at significant frequency. In particular, for finished products, the mean number of spells for exporter-importer-product pairs among East Asian countries reaches 1.96; 53% of the pairs experience multiple spells, more than half of which, 29% experience more than two spells. Besides, short-lived trade relationships are more common than expected. As for overall world trade, the mean length of spells is 3.4-4.2 years, and 48-54% of trade relationships survive only a year.

The frequent breaks and restorations of trade relationships with short lives are noticeable for finished products compared to parts & components for each of the four disaggregated trade flows as well as for overall world trade. In this regard, however, trade relationships among East Asian countries have a notably long duration particularly for parts & components: the mean length of spells is 6.3 years, which is 2.1-2.4 years longer than the corresponding figures for other trade flows, and 55% of the trade relationships survive at least three years. In the case of

finished products, despite the observed frequent breaks and restorations, intra-East Asian trade relationships still have a longer duration than the world average: the mean length of spells is 4.5 years, which is 1.1-1.3 years longer compared to the others, with the median spell length of two.

## 3. Survival of trade in machinery

The last section highlights the fact that machinery parts & components on average have a longer duration with less frequent interruptions than finished products, particularly for intra-East Asian trade. To investigate such East Asian specificity in terms of a higher probability of the continuance of trading, as well as examining the difference in the probability of continuance between parts & components and finished products, this section performs survival analysis in two steps.

### 3.1. Kaplan-Meier estimation

As a first step, this subsection examines the difference in the probability of the survival of trade relationships, *i.e.*, continuance of trading, between machinery parts & components and finished products, employing the nonparametric Kaplan-Meier method. Also, the probability of survival for intra-East Asian trade is to be compared with East Asian exports to and imports from other regions as well as transactions outside the region. Estimated Kaplan-Meier survival rates for bilateral trade relationships at the product-line level are reported in Table 4, and the corresponding survival and hazard functions are graphed in Figures 1 and 2, respectively.[1] Estimated survival rates for overall world trade are reported by product type, and for each of the

[1] The survival function is estimated using the Kaplan-Meier product limit estimator, along the lines of Besedeš and Prusa (2006a) and other previous studies. The hazard function is estimated using the usual smoothing Kernel (epanechnikov) technique with a limited graphing range. The survival function of $T$, the time to failure event, is given by $S(t)=\Pr(T>t)$. $S(t)$ equals one at $t=0$ and decreases towards zero as $t$ increases. The hazard function is given by $h(t)=\Pr(T=t \mid T\geq t)$. The survival and hazard functions are just alternative ways to express the same underlying failure process.

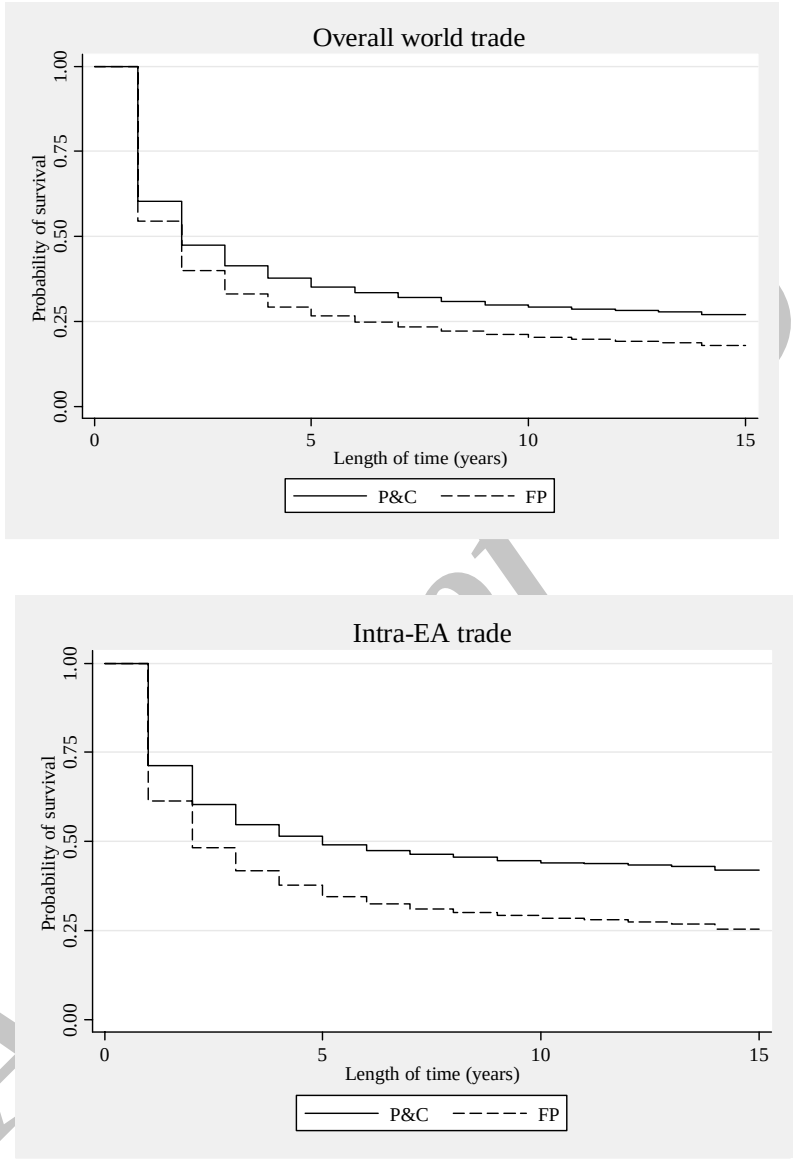
product types, the figures for the four disaggregated trade flows are compared with one another. In addition, as for Figures 1 and 2, the survival and hazard curves for intra-East Asian trade are displayed by product type, with particular interest in the East Asian specificity.

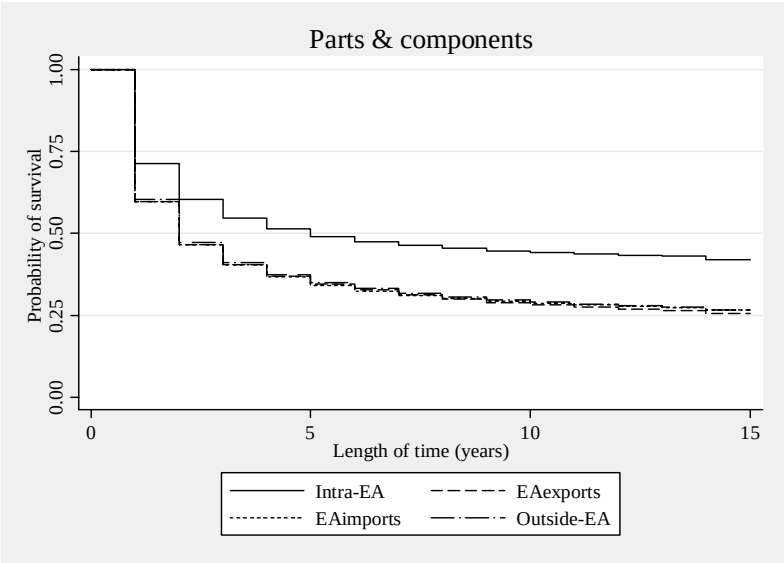
**Table 4. Estimated Kaplan-Meier survival rates for bilateral trade relationships at the product-line level in trade in machinery.**

| | Estimated K-M survival rate | | | | | Obs. |
|---|---|---|---|---|---|---|
| | 1st year | 2nd year | 4th year | 7th year | 10th year | |
| Overall world trade | | | | | | |
| P&C | 0.60 | 0.47 | 0.38 | 0.32 | 0.29 | 1,747,297 |
| FP | 0.54 | 0.40 | 0.29 | 0.23 | 0.20 | 2,410,649 |
| P&C | | | | | | |
| Intra-EA trade | 0.71 | 0.60 | 0.51 | 0.46 | 0.44 | 48,929 |
| EA exports to other regions | 0.60 | 0.47 | 0.37 | 0.31 | 0.28 | 354,676 |
| EA imports from other regions | 0.60 | 0.47 | 0.37 | 0.31 | 0.29 | 165,533 |
| Outside-EA trade | 0.60 | 0.47 | 0.37 | 0.32 | 0.29 | 1,178,159 |
| FP | | | | | | |
| Intra-EA trade | 0.61 | 0.48 | 0.38 | 0.31 | 0.29 | 78,682 |
| EA exports to other regions | 0.55 | 0.40 | 0.30 | 0.24 | 0.21 | 482,527 |
| EA imports from other regions | 0.53 | 0.39 | 0.28 | 0.21 | 0.18 | 209,059 |
| Outside-EA trade | 0.54 | 0.40 | 0.29 | 0.23 | 0.20 | 1,640,381 |

*Notes*: The difference of survival function between parts & components and finished products is significant at the 1% level using the log-rank test, for overall world trade in machinery as well as for each of the disaggregated trade flows. As for trade in parts & components, the difference of survival function between each pair of the disaggregated trade flows (six pairs in total) is significant at the 1% level using the log-rank test, except that the difference between East Asian exports to other regions and East Asian imports from other regions is not significant even at the 10% level. As for trade in finished products, the difference of survival function between each pair of the disaggregated trade flows is significant at the 1% level using the log-rank test.

**Figure 1. Kaplan-Meier estimates of survival functions for trade in machinery.**




Parts & components
Probability of survival
0.00
0.25
0.50
0.75
1.00
0
5
10
15
Length of time (years)
Intra-EA
EAexports
EAimports
Outside-EA

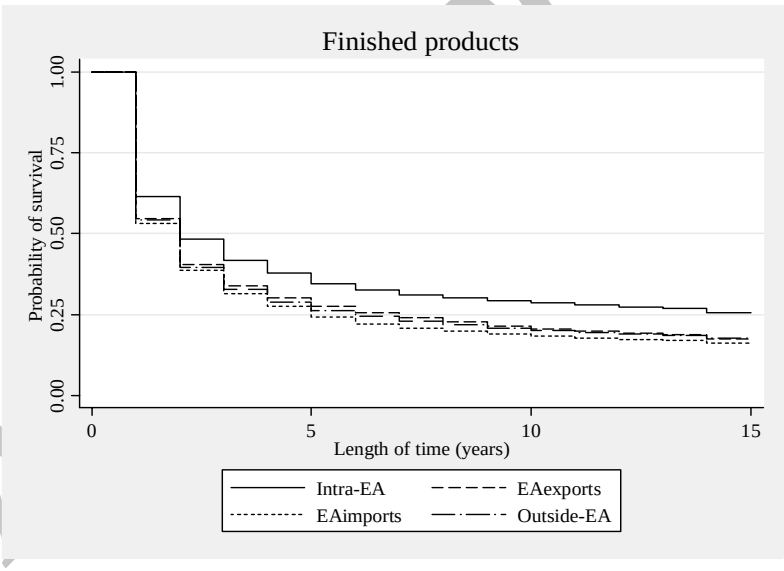
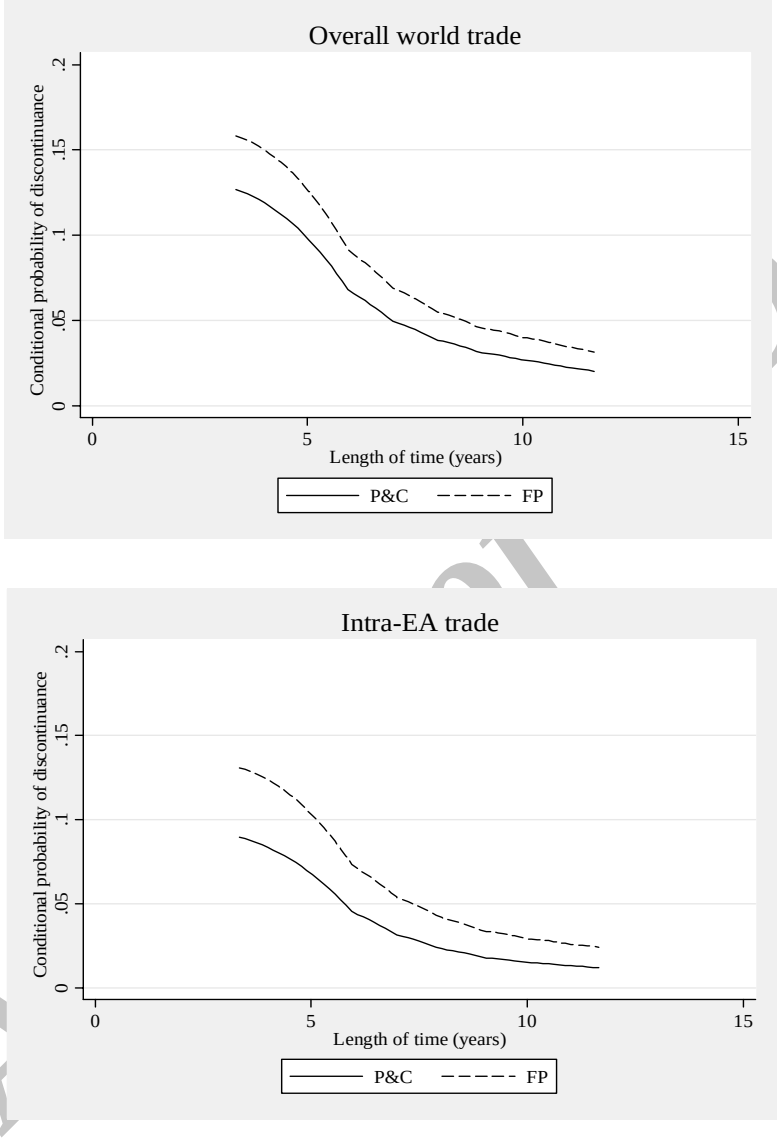
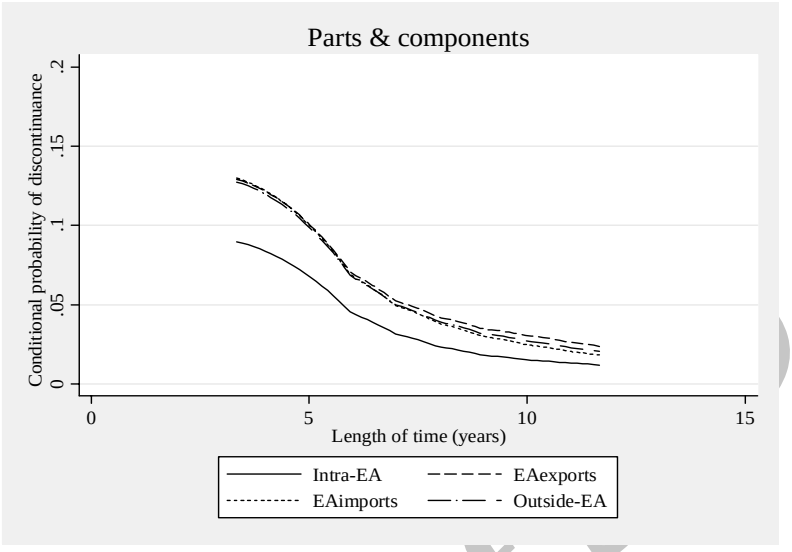
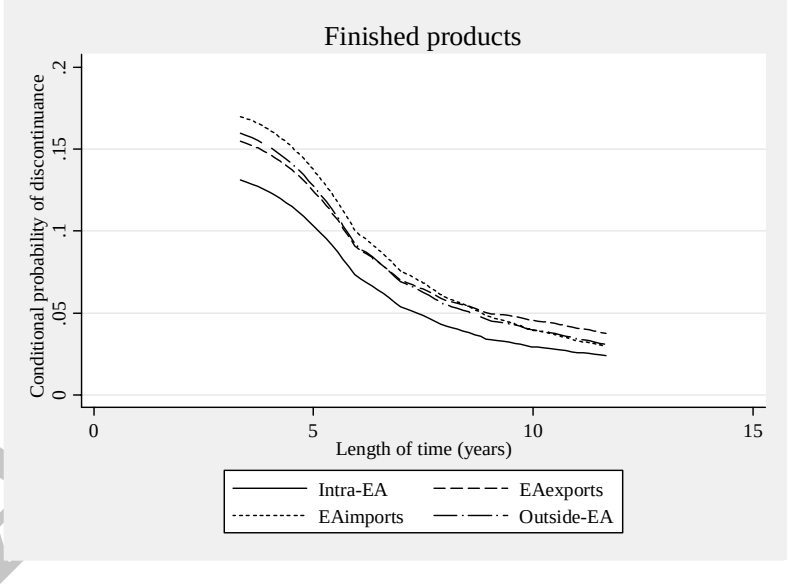

Finished products
Probability of survival
0.00
0.25
0.50
0.75
1.00
0
5
10
15
Length of time (years)
Intra-EA
EAexports
EAimports
Outside-EA

**Figure 2. Kaplan-Meier estimates of hazard functions for trade in machinery.**




Parts & components
Conditional probability of discontinuance
0
.05
.1
.15
.2
0
5
10
15
Length of time (years)
Intra-EA
EAexports
EAimports
Outside-EA


Finished products
Conditional probability of discontinuance
0
.05
.1
.15
.2
0
5
10
15
Length of time (years)
Intra-EA
EAexports
EAimports
Outside-EA

As for overall world trade, estimated survival rates are reported in the upper part of Table 4, and the corresponding survival and hazard curves are at the upper left in Figures 1 and 2. Irrespective of product type, a substantial portion of trade relationships fail within the first few years, especially in the first year when the survival rates, *i.e.*, the probability of survival, are 54-60%. To be more precise, 40-46% of the newly launched transactions at the country level are disrupted within a year, and remain inactive for at least another one year period. For the later years, the survival rates slowly decline by only 6% between the fourth and seventh years, and remain nearly constant afterwards.[1] Indeed, the shape of estimated survival functions for parts & components and finished products look similar: both curves are downward sloping with a decreasing slope. A kind of threshold effect is observed, as is also evidenced by the shape of estimated hazard functions.

The hazard rate here is the conditional probability of discontinuance; to be more precise, the probability that a particular product will not be traded between an exporter-importer pair in the *t*-th year given that it has been traded until the previous year. The hazard rate is at a high level, reaching 13-16%, in the earlier years, but then sharply decreases once a trade relationship last for a certain period of time. It appears that the slope of the hazard curve is steepest from the fifth to sixth year, and beyond around the sixth year as a turning point, the slope is gradually decreasing. The hazard rate falls below 5% at the seventh to eighth year.

Despite similar shapes of the survival and hazard curves, there should be more emphasis on the fact that survival rates are higher for parts & components than finished products at any point of time. In addition, the gap in survival rate between parts & components and finished products remains at 6-9% over time; or rather, the distance between the survival curves is slightly widening in the earlier years and then nearly unchanged. The hazard rates for parts & components also continues to be lower than that for finished products without intersection and the

[1] Spells ended in 2007, the end year of the sample, are classified as right-censored, *i.e.*, continued, rather than failures, *i.e.*, discontinued. It must be appropriate to interpret the length of the right-censored spells as a minimum.

distance between the hazard curves is larger in the earlier years, as reflected in the widening distance between the survival curves during that time.

These features of survival and hazard functions are commonly observed for the disaggregated trade flows. As for intra-East Asian trade, the survival and hazard curves are graphed at the upper right in Figures 1 and 2. Moreover, for each of product types, survival rates vary little among different trade flows except for intra-East Asian trade relationships. As is obvious from the lower two graphs in Figure 1, for East Asian exports to and imports from other regions and outside-East Asia trade, the survival curves follow a similar trajectory though the order of curves is not constant over time in the case of parts & components. The same holds for the hazard curves graphed in the lower part of Figure 2, but the curves intersect one another in the case of finished products as well.

It is striking that intra-East Asian trade relationships face a much higher probability of survival than other trade flows, particularly in the case of parts & components. 71% of the intra-East Asian trade relationships of parts & components survive the first year, and more than half of those (51%) survive for at least four years though the survival rates slowly decline from 51% in the fourth year to 46% in the seventh year. Even in the case of finished products, nearly half (48%) of the trade relationships survive for at least two years. Likewise, the hazard curves for intra-East Asian trade relationships are lower than the others.

Much more noteworthy is that the lower hazard rate for intra-East Asian trade relationships is noticeable in the earlier years, particularly in the case of parts & components. The hazard rate for the intra-East Asian trade relationships of parts & components is less than 10% even in the early stage of the transactions while the corresponding figures for other trade flows stand at 13%. Reflecting such a considerable difference in the hazard rate for parts & components, a widening gap in the survival rate between intra-East Asian trade relationships and the others is observed in the earlier years. From another angle, the slope of the hazard curve for intra-East Asian trade relationships is relatively gentle in the earlier years as compared with the others, particularly in the case of parts &

components. Consequently, the curves tend to converge as the transactions last longer.[1]

### 3.2. Cox proportional hazards estimation

As a second step, in order to confirm the lower hazard rate for machinery parts & components than finished products, the Cox proportional hazards model is estimated, considering factors that may influence the duration of trade. The lower hazard rate for intra-East Asian trade relationships compared to other trade flows is also to be examined. The semi-parametric Cox proportional hazards model asserts that the hazard rate for the *m*-th subject in the sample is

$$h(t \mid \mathbf{x}_m) = h_0(t) \exp(\mathbf{x}_m \boldsymbol{\beta}),$$

where $\mathbf{x}_m$ denotes a vector of *m*-th subject's covariates and coefficients $\boldsymbol{\beta}$ are to be estimated.[2] The Cox model is by far the most popular choice in the analysis of survival data. A particular advantage of the model is that the baseline hazard function, $h_0(t)$, is left unspecified and not estimated. What is assumed is that the covariates multiplicatively shift the baseline hazard which is common to all the subjects.[3] The hazard rate for individual subject equals to the baseline hazard when the value of all covariates is set to zero. Exponentiated respective coefficients are then interpreted as the ratio of the hazard rates, which is referred to as hazard ratio, for a one-unit change in the corresponding covariate. Hazard ratio is greater than one if the corresponding covariate negatively affects the duration of trade, and vice versa. A ratio equal to one implies no impact

[1] These features are robust even after considering the left-censoring issue and possible recording errors though estimated survival and hazard functions vary among different modified samples. Results are available on request. As for intra-East Asian trade in machinery, estimated Kaplan-Meier survival rates and the corresponding survival curves by different samples are reported in Obashi (2010).

[2] As the Cox model is a continuous model while the survival data used in this paper is on an annual basis, in which some failures occur at the same survival time (year), the Breslow (1974)'s approximation is assumed so as to treat tied failures.

[3] In this regard, however, estimation is to be stratified by machinery subsector, *i.e.*, general machinery (HS84), electric machinery (HS85), transport equipment (HS86-89), and precision machinery (HS90-92), allowing the baseline hazard to vary among strata.

on the duration of trade. Due to limitations of data capacity, the Cox model is estimated simply using time-invariant covariates as well as control variables. Our interest is focused on estimated coefficients for a dummy variable which takes a value of one if a trade relationship is of parts & components and for a dummy variable taking a value of one for intra-East Asian trade relationships. The hazard ratios for the parts & components dummy and the intra-East Asia dummy are expected to be less than one even after considering factors behind the duration of trade. An interaction term of the parts & components dummy with the intra-East Asia dummy is also to be included in the estimation.

As for pair-specific characteristics, distance and dummy variables for common border and common official language are included.[1] In the gravity literature, it is well known that countries at smaller distance and sharing a common border and a common language tend to trade more with each other. These variables might also affect the duration of trade through pushing up or lowering the cost of trading.

To control the impact of the initial size of transaction on the duration of trade, the logarithm of trade value in the first year is included.[2] A trade relationship started with a smaller trade value at the country level, which is probably economically less important for either or both of exporter and importer countries in the beginning, may face a greater risk of discontinuance. Instead of applying the cutoff value to trade data, the initial trade value is taken into consideration. Regarding the prevalence of multiple spells, a dummy variable for subsequent spells is included, following Besedeš and Prusa (2006b). Although multiple spells are treated as independent because separated spells are highly likely to involve different firms of exporter and importer countries, the probability of survival will depend on the country-level experience of discontinuance. A trade relationship restarted after a certain period of no trade may not fail again, owing to accumulated information about the trade counterpart at the country level. Besides these two control variables, exporter country, importer country and year fixed effects are included to control for unobserved characteristics. Standard errors are

[1] These three variables are obtained from the CEPII's distance measure database.

[2] Trade value data is deflated by the wholesale price index (WPI) in the US to obtain a constant dollar series.

clustered at the HS 6-digit product line level, allowing for possible correlation within products.

Table 5 provides the Cox proportional hazards estimates for bilateral trade relationships at the product level in overall world trade in machinery during 1993-2007. The sample of interest is listed at the top of each column, and covariates and control variables are in the first left column of the table. Units in which respective continuous variables are measured are in parentheses.[1] Estimated coefficients are expressed in terms of hazard ratios, and we are interested in the difference from one, as mentioned above.

**Table 5. Cox proportional hazards estimates for overall world trade in machinery.**

| | All machineries | | | P&C | FP |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | | |
| P&C dummy | 0.776** | 0.776** | 0.778** | | |
| | (0.001) | (0.001) | (0.001) | | |
| Intra-EA dummy | | 0.979** | 1.018** | 0.950** | 0.998 |
| | | (0.005) | (0.006) | (0.009) | (0.006) |
| P&C * Intra-EA | | | 0.893** | | |
| | | | (0.007) | | |
| Distance (1,000km) | 1.013** | 1.012** | 1.012** | 1.013** | 1.013** |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) |
| Border dummy | 0.905** | 0.904** | 0.904** | 0.909** | 0.896** |
| | (0.003) | (0.003) | (0.003) | (0.008) | (0.006) |
| Language dummy | 0.918** | 0.918** | 0.918** | 0.921** | 0.914** |
| | (0.002) | (0.002) | (0.002) | (0.005) | (0.004) |
| Log of initial trade value (US$) | 0.891** | 0.891** | 0.891** | 0.864** | 0.903** |
| | (0.000) | (0.000) | (0.000) | (0.004) | (0.002) |
| Subsequent spells dummy | 0.689** | 0.689** | 0.689** | 0.688** | 0.689** |
| | (0.001) | (0.001) | (0.001) | (0.003) | (0.003) |
| Obs. (N. of spells) | 4,070,719 | 4,070,719 | 4,070,719 | 1,709,526 | 2,361,193 |
| N. of failures | 2,867,055 | 2,867,055 | 2,867,055 | 1,129,008 | 1,738,047 |
| Log likelihood | -38,452,918 | -38,452,909 | -38,452,797 | -14,201,542 | -22,361,608 |

*Notes*: The trade flows of interest are listed at the top of each column and the covariates are in the first left column. Coefficients are expressed as hazard ratios. Robust standard errors clustered by product are in parentheses. ** and * indicate significance (difference from one) at the 1% and 5% level. All regressions include country and year fixed effects, but those coefficient estimates are not reported for brevity. The estimates are stratified by machinery subsectors. Multiple spells of respective exporter-importer-product pairs are treated as independent. Trade value data are in constant 2000 U.S. dollars.

[1] The unit in which a variable is measured makes no substantive difference.

The results for trade relationships of all machinery goods are reported in the left part of Table 5. First of all, the estimated coefficient, *i.e.*, hazard ratio, for the parts & components dummy is 0.776 in Equation (1), which indicates the lower hazard rate for parts & components than finished products: with allowing trade relationships of finished products to be a benchmark, those of parts & components have an 22.4% lower hazard rate. In other words, for parts & components, once a trade relationship is developed, it is 22.4% less likely to be broken off.[1] As for effects of other covariates on the hazard rate, all of them are estimated as expected.

The result of Equation (2), which is estimated including the intra-East Asia dummy, shows that intra-East Asian trade relationships have a 2.1% lower hazard rate with respect to other trade flows, *i.e.*, East Asian exports to and imports from other regions as well as transactions outside the region. Once an interaction term of the parts & components dummy with the intra-East Asia dummy is introduced in Equation (3), however, the estimated hazard ratio for the intra-East Asia dummy turns greater than one, at 1.018, while the lower hazard rate for parts & components still holds. At the same time, the hazard ratio for the interaction term is estimated to be less than one, at 0.893. Intra-East Asian trade relationships themselves have a 1.8% higher hazard rate with respect to the other trade flows; whereas, in addition to the lower hazard rate for parts & components than finished products, the intra-East Asian trade relationships of parts & components have an extra 10.7% lower hazard rate with respect to other transactions.

Based on the result of Equation (3), the lower hazard rate for intra-East Asian trade relationships of parts & components can be confirmed by calculating the relative hazard rate for each of the following four types of transactions: intra-East Asian trade relationships of parts & components, those of finished products, other transactions (all transactions other than intra-East Asian ones) of parts & components, and those of finished products. For example, when the other

[1] In contrast, Besedeš (2008) finds that for the US imports from developing countries, trade relationships of intermediate goods face about 10% higher probability of discontinuance than those of final goods, though he examines all the merchandise trade including not only manufactured goods but also agricultural goods and mineral fuels.

transactions of finished products are taken as a benchmark and their hazard rate is normalized to unity, the relative hazard rate for intra-East Asian trade relationships of parts & components can be obtained as the product of relevant hazard ratios, 0.778*1.018*0.893=0.707. By the same token, the relative hazard rates are 1.018 and 0.778 for intra-East Asian trade relationships of finished products and for other transactions of parts & components, respectively. Intra-East Asian trade relationships of parts & components indeed achieve a notably low hazard rate, in sharp contrast with the case of those of finished products.

For the right two columns of Table 5, the same Cox model is estimated separately for parts & components and finished products, assuming that the baseline hazard is shaped differently by product type. By employing this approach, although we do not care how the product type proportionally shifts a common baseline hazard, we can measure effects of covariates on the hazard rate correctly for each product type. In fact, estimated hazard ratios are similar in direction but different in magnitude and significance by product type. It is worth noting that the estimated hazard ratio for the intra-East Asia dummy in the case of parts & components is significantly less than one, at 0.950, while the corresponding estimate for finished products is barely less than one but insignificant even at the 10% level. Intra-East Asian trade relationships have a 5% lower hazard rate with respect to other trade flows when they are of parts & components, but such a difference is not significantly detected in the case of finished products.

Table 6 compares the Cox proportional hazards estimates between the four disaggregated trade flows. A set of variables are the same as in Equation (1) of Table 5. Estimated hazard ratios for the parts & components dummy are significant and less than one for all the trade flows, confirming the lower hazard rate for parts & components than finished products as common characteristic. In this regard, however, the hazard ratio ranges from 0.690 to 0.810 and is the lowest for intra-East Asian trade. The difference in the hazard rate between parts & components and finished products is especially prominent in transactions within the East Asian region. Estimated hazard ratios for other covariates are qualitatively similar to those reported in Table 5, except that the hazard ratios for the border dummy are estimated to be

greater than one for intra-East Asian trade and East Asian exports to and imports from other regions, which seem to be due to multicollinearity with the distance variable.[1]

**Table 6. Cox proportional hazards estimates: comparison of the disaggregated trade flows.**

| | Intra-EA trade | EA exports to other regions | EA imports from other regions | Outside-EA trade |
|---|---|---|---|---|
| P&C dummy | 0.690** | 0.810** | 0.733** | 0.774** |
| | (0.016) | (0.012) | (0.013) | (0.013) |
| Distance (1,000km) | 1.063** | 1.026** | 1.016** | 1.016** |
| | (0.003) | (0.001) | (0.002) | (0.001) |
| Border dummy | 1.130** | 1.057** | 1.183** | 0.879** |
| | (0.013) | (0.008) | (0.015) | (0.005) |
| Language dummy | 0.955** | 0.982** | 0.995 | 0.905** |
| | (0.010) | (0.005) | (0.006) | (0.003) |
| Log of initial trade value (US$) | 0.861** | 0.892** | 0.903** | 0.891** |
| | (0.003) | (0.002) | (0.002) | (0.002) |
| Subsequent spells dummy | 0.677** | 0.669** | 0.695** | 0.691** |
| | (0.006) | (0.003) | (0.003) | (0.002) |
| Obs. (N. of spells) | 127,611 | 830,916 | 373,190 | 2,739,002 |
| N. of failures | 80,238 | 580,312 | 267,478 | 1,939,027 |
| Log likelihood | -796,048 | -6,866,358 | -2,945,356 | -25,235,873 |

*Note*: See notes of Table 5.

To further investigate the East Asian specificity in the sense that East Asian countries engage in less-discontinued, *i.e.*, longer-lived, trade relationships with each other than with outsiders as well as compared to outside the region, the hazard ratios for the intra-East Asia dummy and its interaction term with the parts & components dummy reported in Table 5 are reconsidered. The corresponding estimates for East Asian exports and imports are reported in Tables 7 and 8, respectively. Unlike in the case of overall world trade in Table 5, here we can focus directly on comparing intra-regional trade partners with outsiders.

[1] As a robustness check, I estimated the equations including exporter-importer-pair fixed effects instead of the three pair-specific variables, and estimated hazard coefficients for the parts & components dummy are not substantially changed. In this regard, however, I could not employ a large number of the pair dummies in the case of outside-East Asia trade because of data capacity limitations.

**Table 7. Cox proportional hazards estimates for East Asian exports.**

| | All machineries | | | P&C | FP |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | | |
| P&C dummy | 0.793** | 0.793** | 0.807** | | |
| | (0.012) | (0.012) | (0.012) | | |
| Intra-EA dummy | | 0.974 | 1.025 | 0.941* | 1.006 |
| | | (0.016) | (0.017) | (0.025) | (0.020) |
| P&C * Intra-EA | | | 0.861** | | |
| | | | (0.013) | | |
| Distance (1,000km) | 1.030** | 1.030** | 1.030** | 1.037** | 1.029** |
| | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) |
| Border dummy | 1.053** | 1.053** | 1.052** | 1.048** | 1.057** |
| | (0.006) | (0.006) | (0.006) | (0.010) | (0.008) |
| Language dummy | 0.978** | 0.978** | 0.976** | 0.974** | 0.980** |
| | (0.005) | (0.005) | (0.005) | (0.008) | (0.006) |
| Log of initial trade value (US$) | 0.886** | 0.886** | 0.886** | 0.864** | 0.896** |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) |
| Subsequent spells dummy | 0.675** | 0.675** | 0.674** | 0.669** | 0.678** |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.004) |
| Obs. (N. of spells) | 958,527 | 958,527 | 958,527 | 401,068 | 557,459 |
| N. of failures | 660,550 | 660,550 | 660,550 | 260,234 | 400,316 |
| Log likelihood | -7,905,674 | -7,905,674 | -7,905,497 | -2,896,918 | -4,572,999 |

*Note*: See notes of Table 5.

**Table 8. Cox proportional hazards estimates for East Asian imports.**

| | All machineries | | | P&C | FP |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | | |
| P&C dummy | 0.722** | 0.722** | 0.732** | | |
| | (0.013) | (0.013) | (0.013) | | |
| Intra-EA dummy | | 1.093** | 1.121** | 1.033 | 1.172** |
| | | (0.021) | (0.022) | (0.029) | (0.031) |
| P&C * Intra-EA | | | 0.939** | | |
| | | | (0.014) | | |
| Distance (1,000km) | 1.039** | 1.039** | 1.039** | 1.035** | 1.043** |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.002) |
| Border dummy | 1.064** | 1.064** | 1.062** | 1.089** | 1.056** |
| | (0.008) | (0.008) | (0.008) | (0.014) | (0.010) |
| Language dummy | 1.004 | 1.004 | 1.004 | 1.012 | 0.994 |
| | (0.005) | (0.005) | (0.005) | (0.009) | (0.007) |
| Log of initial trade value (US$) | 0.892** | 0.892** | 0.892** | 0.862** | 0.906** |
| | (0.002) | (0.002) | (0.002) | (0.004) | (0.003) |
| Subsequent spells dummy | 0.694** | 0.694** | 0.694** | 0.690** | 0.696** |
| | (0.003) | (0.003) | (0.003) | (0.005) | (0.004) |
| Obs. (N. of spells) | 500,801 | 500,801 | 500,801 | 213,587 | 287,214 |
| N. of failures | 347,716 | 347,716 | 347,716 | 136,384 | 211,332 |
| Log likelihood | -3,928,070 | -3,928,070 | -3,928,042 | -1,426,979 | -2,271,105 |

*Note*: See notes of Table 5.

As in the case of overall world trade, East Asian exports of parts & components face a 19.3-20.7% lower hazard rate with respect to those of finished products. East Asian imports of parts & components also face a 26.8-27.8% lower hazard rate. A notable difference between East Asian exports and imports is the estimated hazard ratio for the intra-East Asia dummy. For the export side, the intra-East Asia dummy loses its significance, regardless of whether or not the interaction term for the parts & components and intra-East Asia dummies is considered. On the other hand, the corresponding estimates in the case of East Asian imports are significantly greater than one, at 1.093 and 1.121. While the hazard rate does not significantly differ between intra- and extra-regional exports, the hazard rate is 12.1% higher for East Asian imports within than from outside the region, even after considering the interaction term. Nevertheless, for both export and import sides, on top of the lower hazard rate for parts & components, the intra-regional trade relationships of parts & components have a 6.1-13.9% lower hazard rate with respect to other transactions.

As discussed above, by calculating the relative hazard rates for different types of the trade relationships of interest in the estimated equation, *i.e.*, Equations (3) of Tables 7 and 8, we can check that East Asian countries enjoy a relatively low hazard rate for parts & components with intra-regional trade partners only for the export side. When the hazard rate for extra-regional exports of finished products is set to unity as a benchmark, the relative hazard rates are 0.807*0.861=0.695 and 0.807 for intra-regional exports of parts & components and for extra-regional exports of parts & components. Since hazard ratio for the intra-East Asia dummy is estimated as insignificant, the relative hazard rate for intra-regional exports of finished products is considered as not significantly different from one. In the case of East Asian imports, on the other hand, extra-regional imports of parts & components face the lowest relative hazard rate (0.732), followed by intra-regional imports of parts & components (0.732*1.121*0.939=0.771), extra-regional imports of finished products (set to unity as a benchmark), and intra-regional imports of finished products (1.121).

The difference in the estimated hazard ratio for the intra-East Asia dummy between East Asian exports and imports is further examined by conducting the estimation separately for parts & components and finished products. For the export side, the hazard ratio for the intra-East Asia dummy is estimated to be significantly less than one, at 0.941, in the parts equation, while the corresponding estimate for finished products is insignificant, as in the case of overall world trade. By contrast, for the import side, the intra-East Asia dummy loses its significance in the parts equation, while the estimate for finished products is significantly greater than one, at 1.172. In other words, when limiting our focus on East Asian exports and imports by excluding the transactions outside the region, the hazard rates significantly differ between intra-regional trade partners and outsiders only in the cases of exports of parts & components and imports of finished products.[1] More interestingly, the intra-regional exports of parts & components face a 5.9% lower hazard rate with respect to the extra-regional exports, whereas such East Asian specificity acts in the opposite direction in the case of imports of finished products: the hazard rate is 17.2% higher with intra-regional partners than with outsiders.[2]

## 4. Conclusion

A series of survival analyses provided an evidence supporting the view that not only within East Asia but at the global level, the ongoing trade relationships of intermediate goods built through production chains are more lasting compared to other transactions. Contrary to the public perception of globalizing business activities as footloose investments, the stability of international production networks has been verified in the wider global context. More importantly, the relative

[1] Based on the result of Equation (3) in Table 8, extra-regional imports of parts & components face a lower hazard rate than intra-regional imports of parts & components, as mentioned in the previous paragraph. When conducting the estimation only for trade relationships of parts & components, however, no significant difference in the hazard rate is detected between extra- and intra-regional imports.

[2] Even after considering the left-censoring issue and possible recording errors, results are not qualitatively different from those reported in this subsection. Further results are available on request.

probability of continuance for the transactions of intermediate goods within international production networks seems to be notably higher for intra-East Asian trade than for extra-regional trade as well as transactions outside the region. This can be interpreted as suggesting that the stability of international production networks is a particularly prominent feature of East Asia.

After considering various factors behind the duration of trade, intra-East Asian trade relationships are on average more likely to be broken off rather than lasting, compared to extra-regional transactions as well as those outside the region. Nevertheless, in contrast with the overall trend, the intra-East Asian trade relationships of intermediate goods are highly lasting as compared to all other transactions. Particularly for the export side, East Asian countries are more likely to engage in long-lasting trade relationships of intermediate goods with intra-regional partners than with outsiders, unlike in the case of finished products. It appears that the East Asian specificity in terms of a higher probability of continuance for intra-regional trade is confined to the transactions of intermediate goods within international production networks. Such East Asian specificity, however, is not statistically verified for imports of intermediate goods. Given the fact that not only Japanese but also the US and European firms are active in relocating production sites to developing Asian countries to take advantage of the cheap labor, imports of intermediate goods from the US or European investor countries for assembly of the product may face less risk of discontinuance in a similar way to intra-East Asian transactions within international production networks. This possible interpretation can be also given to the empirical result that the probability of continuance does not statistically differ between intra-regional and extra-regional exports of finished products: the products assembled in developing Asian countries may be steadily exported back to the US and European investor countries.

With increasing intra-regional economic interdependence through production chains, East Asian countries have developed long-lasting trade relationships of intermediate goods with each other, which would foster continuing strong growth in intra-regional trade and the regional dynamism. In addition to regional diversity in income levels and

development stages by nature, policy settings more favorable for international fragmentation of production such as more advanced utilization of FTAs as well as trade liberalization and facilitation policies will accelerate the building of long-lasting trade relationships across East Asia.

**Appendix A1. Data construction.**

I have cleaned up raw data obtained from the UN Comtrade as follows:

(1) As of February 2010, the UN Comtrade offers annual trade statistics reported by 249 countries/regions in total, including country groups provided by default. The number of the countries/regions/country groups that are listed in the UN Comtrade reference table as a trade partner, *i.e.*, export destination or import origin, reaches 288. As we focus on bilateral trade between individual countries, we need to exclude data for country groups such as World (0), EU27 (97), and Southern African Customs Union (711).[1]

(2) In addition, the UN database includes data on some countries/ regions' exports to and imports from countries/regions not elsewhere specified or included. The following trade data without a specified single trade partner are dropped from sample: Eastern Europe, nes (221), Northern Africa, nes (290), CACM, nes (471), Africa CAMEU region, nes (472), South America, nes (473), Asia, nes (490), Oceania, nes (527), Europe, nes (568), Africa, nes (577), United States Minor Outlying Islands (581), North America, the Caribbean and Central America not elsewhere specified (637), Europe EFTA, nes (697), US Miscellaneous Pacific Islands (849), Western Asia, nes (879), and Areas, nes (899). Data for unspecified regions such as Neutral zone (536), Bunkers (837), Free Zones (838), and Special categories, Secret & Difference (839) also need to be excluded.

(3) Cases in which trade data at country/region level discontinued to be reported due to changes in country/region classification are weeded out. The problematical country codes that ceased to exist during the period

[1] The corresponding ISO 3166-1 numeric country/region codes are in parentheses.

of interest, 1993-2007, are as follows: Belgium-Luxembourg (58), French Guiana (254), Guadeloupe (312), Martinique (474), and Serbia and Montenegro (891).[1] Montenegro (499) and Serbia (688) are also excluded because these codes have been newly added since 2006, just one year before the end of sample period.

(4) As for France, Italy, and the United States, since some countries/regions are subsumed within two or more country/region codes, we need to select out codes so as to get rid of possible overlaps. In the case of France, for example, France (including Monaco) (251) is selected, while Monaco (492)[2] is excluded from the sample. As for Italy, Italy (including San Marino and Holy See) (381) is included in the sample, but other relevant codes, such as Holy See (Vatican City State) (336) and San Marino (674), are excluded. As for the US, USA (including Puerto Rico and US Virgin Islands) (842) is included, but other relevant codes, such as Puerto Rico (630) and US Virgin Islands (850), are excluded. Similarly, Saint Kitts, Nevis and Anguilla (658) is dropped from sample because trade statistics for Saint Kitts and Nevis (659) and Anguilla (660) are also reported separately.[3]

(5) Since the annual data at the HS 6-digit level below $500 (current US$) are not reported before 2000, trade flows below $500 are treated as if there was no trade at all for all the years in sample.

(6) After the cutoff value of $500 is applied, all trade data are deflated by the wholesale price index in the US to obtain a constant dollar series.

After cleaning up raw data obtained from the UN Comtrade, 225 countries/regions out of 288 countries/regions/country groups remain in sample.[4] Among them, 54 countries/regions have continuously reported trade statistics based on the HS classification during the sample

[1] Belgium-Luxembourg (58) had been valid until 1998, French Guiana (254) until 1995, Guadeloupe (312) until 1995, Martinique (474) until 1995, and Serbia and Montenegro (891) until 2005.

[2] Monaco (492) has been mapped to Europe, nes (568) since 2005.

[3] Among these codes, only codes 336, 492, and 674 actually exist in the database though all the codes are listed in the UN Comtrade reference table.

[4] 225 sample countries/regions comprise 188 UN member countries (out of 192, as of February 2010), 15 countries listed in the UN list of non-self-governing territories (out of 16, as of 2006), and others.

period 1993-2007. In order to avoid misleading disruptions of transactions due to a lack of statistics, this paper focuses exclusively on trade statistics reported by the following 54 countries:

**The continuing reporters in 1993-2007**

Algeria (12); Argentina (32); Australia (36); Bolivia (68); Brazil (76); Belize (84); Burundi (108); Canada (124); Chile (152); China (156); Colombia (170); Croatia (191); Cyprus (196); Czech Rep. (203); Denmark (208); Ecuador (218); Finland (246); Germany (276); Greece (300); Grenada (308); Guatemala (320); China, Hong Kong SAR (344); Hungary (348); Iceland (352); Indonesia (360); Ireland (372); Japan (392); Rep. of Korea (410); China, Macao SAR (446); Madagascar (450); Malaysia (458); Mauritius (480); Mexico (484); Mozambique (508); Oman (512); Netherlands (528); New Zealand (554); Nicaragua (558); Norway (579); Paraguay (600); Portugal (620); Romania (642); Saint Lucia (662); India (699); Singapore (702); Spain (724); Sweden (752); Switzerland (757); Thailand (764); Trinidad and Tobago (780); Tunisia (788); Turkey (792); United Kingdom (826); USA (842)

This paper basically uses import statistics, whenever they are available, from the standpoint of reliability, because country of origin is more closely verified due to tariff regulations though final destination may not be known at time of export. If the import statistics are not available for an exporter-importer pair, the corresponding export statistics (mirror data) are used instead, following Feenstra *et al.* (2005).

Trade data for all the years in the sample are originally reported based on or modified to fit the 6-digit level of HS 1992 classification. By using the dataset based on the old but unchanging product classification, while we cannot observe the birth of newly-developed products within a ready-made product-line category of the HS 1992 classification, the probability of the discontinuance of trade relationships will be underestimated, but never be overestimated. More importantly, we do not need to concern about the censoring issue emerging from the complicated mergers and branching of codes due to the update of classification.

**Appendix A2. Numbers of exporters/importers and pairs in samples with different cutoffs.**

| | Total number | Proportion to full sample | Number by trade flows | | | |
|---|---|---|---|---|---|---|
| | | | Intra-EA trade | EA exports to other regions | EA imports from other regions | Outside-EA trade |
| Full sample | | | | | | |
| Exporters | 225 | 100% | 9 | 9 | 216 | 216 |
| Importers | 225 | 100% | 9 | 216 | 9 | 216 |
| Exporter-importer pairs | 18,485 | 100% | 72 | 1,720 | 1,673 | 15,020 |
| Exporter-importer pairs that account for 99% of total trade volume | | | | | | |
| Exporters | 151 | 67% | 9 | 9 | 87 | 134 |
| Importers | 177 | 79% | 9 | 141 | 9 | 158 |
| Exporter-importer pairs | 3,277 | 18% | 72 | 630 | 395 | 2,180 |
| Exporter-importer pairs that account for 95% of total trade volume | | | | | | |
| Exporters | 89 | 40% | 9 | 9 | 36 | 79 |
| Importers | 116 | 52% | 9 | 77 | 9 | 96 |
| Exporter-importer pairs | 1,405 | 8% | 71 | 289 | 177 | 867 |

*Notes*: The product of the numbers of exporters and importers is not necessarily equal to the number of exporter-importer pairs. For example, in the full sample, there actually exist 18,485 exporter-importer pairs though 225 exporters and 225 importers can form up to 50,400 pairs. Only 36.7% of the maximum possible number of pairs have engaged in any transactions of manufactured goods with each other during the sample period 1993-2007.

**References**

1- Ando, M., Kimura, F., 2005. The formation of international production and distribution networks in East Asia. In: Ito, T., Rose, A. K. (Eds.). International Trade in East Asia. Chicago: University of Chicago Press, 177-213.

2- Arndt, S.W., Kierzkowski, H., 2001. Fragmentation: New Production Patterns in the World Economy. Oxford: Oxford University Press.

3- Athukorala, P.-C., Yamashita, N., 2006. Production fragmentation and trade integration: East Asia in a global context. The North American Journal of Economics and Finance 17, 233-256.

4- Baldwin, R., 1988. Hysteresis in import prices: The beachhead effect. American Economic Review 78, 773-785.

5- Baldwin, R., Krugman, P., 1989. Persistent trade effects of large exchange rate changes. Quarterly Journal of Economics 104, 821-854.

6- Bernard, A.B., Jensen, B., 2004. Why some firms export. Review of Economics and Statistics 86, 561-569.

7- Besedeš, T., 2008. A search cost perspective on formation and duration of trade. Review of International Economics 16, 835-849.

8- Besedeš, T., Prusa, T.J., 2006a. Ins, outs, and the duration of trade. Canadian Journal of Economics 39, 266-295.

9- Besedeš, T., Prusa, T.J., 2006b. Product differentiation and duration of US import trade. Journal of International Economics 70, 339-358.

10- Blyde, J., 2008. What drives export survival? An analysis on export duration in Latin America. Mimeo.

11- Breslow, N., 1974. Covariance analysis of censored survival data. Biometrics 30, 89-99.

12- Deardorff, A.V., 2001. Fragmentation in simple trade models. The North American Journal of Economics and Finance 12, 121-137.

13- Dixit, A., 1989a. Entry and exit decisions under uncertainty. Journal of Political Economy 97, 620-638.

14- Dixit, A., 1989b. Hysteresis, import penetration, and exchange rate passthrough. Quarterly Journal of Economics 104, 205-228.

15- Feenstra, R.C., Lipsey, R.E., Deng, H., Ma, A.C., Mo, H., 2005. World trade flows: 1962-2000. NBER Working Paper No. 11040.

16- Fukao, K., Ishido, H., Ito, K., 2003. Vertical intra-industry trade and foreign direct investment in East Asia. Journal of the Japanese and International Economies 17, 468-506.

17- Haveman, J., Hummels, D., 2004. Alternative hypotheses and the volume of trade: The gravity equation and the extent of specialization. Canadian Journal of Economics 37, 199-218.

18- Helpman, E., Melitz, M., Rubinstein, Y., 2008. Estimating trade flows: Trading partners and trading volumes. Quarterly Journal of Economics 123, 441-487.

19- Jones, R.W., Kierzkowski, H., 1990. The role of services in production and international trade: A theoretical framework. In: Jones, R.W., Krueger, A.O. (Eds.). The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin. Oxford: Basil Blackwell, 31-48.

20- Kimura, F., 2006. International production and distribution networks in East Asia: Eighteen facts, mechanics, and policy implications. Asian Economic Policy Review 1, 326-344.

21- Kimura, F., Ando, M., 2005. Two-dimensional fragmentation in East Asia: Conceptual framework and empirics. International Review of Economics and Finance 14, 317-348.

22- Nitsch, V., 2009. Die another day: Duration in German import trade. Review of World Economics 145, 133-154.

23- Obashi, A., 2009. Resiliency of production networks in Asia: Evidence from the Asian crisis. ERIA Discussion Paper Series, ERIA-DP-2009-21.

24- Obashi, A., 2010. Stability of production networks in East Asia: Duration and survival of trade. Japan and the World Economy 22, 21-30.

25- Roberts, M., Tybout, J., 1997. The decision to export in Colombia: An empirical model of entry with sunk costs. American Economic Review 87, 545-564.